CANDIDATE'S NUMBER

(For the use of the Department only)

Chemistry 30.

Test

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Aug. 1968

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DEPARTMENT EDUCATION ALBERTA

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DEPARTMENTAL EXAMINATIONS, 1968

AUGUST

Time -- 2 hours

CHEMISTRY 30X

Total Mark -- 99

Note -- This is an OPEN BOOK examination in which texts, references, and notes may be used. It is composed of two parts, Part I and Part II.

Part I, questions 1 through 32 will be machine scored. You are to record your answers on the separate ANSWER SHEET provided.

Part II consists of questions 31 to 39. The answers to Part II must be recorded in this booklet.

In solutions to problems in Part II enough work must be shown to indicate the method used. Include units in your answers.

Candidates are permitted to use slide rules and mathematical tables.

Rough work and diagrams may be done in pencil. Finished work must be done in blue or black ink (pen or ballpoint).

IT IS SUGGESTED THAT THE STUDENT SHOULD DIVIDE HIS TIME APPROXIMATELY $1\frac{1}{4}$ HOURS ON PART I AND $\frac{3}{4}$ HOUR ON PART II.

WRITE YOUR NAME AND SCHOOL IN THE SPACE PROVIDED ON THE ANSWER SHEET TO PART I BUT DO NOT WRITE YOUR NAME ON THIS BOOKLET.

Place your answer sheet BEHIND the test booklet and INSERT BOTH IN THE SAME ENVELOPE in such a way that the UPPER LEFT-HAND CORNER OF THE BOOKLET (Candidate's Number) shows through the SLASHED CORNER of the answer envelope.

BE SURE TO SEAL THE ENVELOPE.

Machine Score
Booklet Score
TOTAL

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3054
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D419
1968a
chem.30X

CURR HIST

PART I

Questions 1-32 are to be machine scored and have a value of two marks each. For each question choose the best possible answer and record it carefully on the ANSWER SHEET provided. Use an ORDINARY HB PENCIL to record your answers. Make sure your marks are heavy and black.

EXAMPLE:	ANSWERS		ANSWER SHEET
The formula for sulphuric acid is	A. H_2SO_2	C. H_2SO_3	A B C D E ☐ ■ ☐ ☐ ☐
	B. H_2SO_4	D. $H_2S_2O_7$	

1. In which of these substances does sulphur have the LOWEST oxidation number?

   A. H_2SO_3

   B. H_2SO_4

   C. $H_2S_2O_7$

   D. H_2S

2. Which of the following can reduce $Cr^{+3}_{(aq)}$ to $Cr^{+2}_{(aq)}$ spontaneously?

   A. $Co_{(s)} \rightarrow Co^{+2}_{(aq)}$

   B. $Fe_{(s)} \rightarrow Fe^{+2}_{(aq)}$

   C. $Zn^{+2}_{(aq)} \rightarrow Zn_{(s)}$

   D. $Cu^{+2}_{(aq)} \rightarrow Cu_{(s)}$

FOR ROUGH WORK ONLY
(No marks given for work in this space)

3. Four hypothetical elements W, X, Y, Z all form gaseous diatomic molecules and each form singly charged negative ions W^-, X^-, Y^-, Z^-. The following equations indicate reactions which do or do not occur spontaneously.

$$2W^- + Y_2 \longrightarrow 2Y^- + W_2 \quad \text{(Reacts spontaneously)}$$

$$2Z^- + X_2 \longrightarrow \quad \text{(No spontaneous reaction)}$$

$$2Y^- + X_2 \longrightarrow 2X^- + Y_2 \quad \text{(Reacts spontaneously)}$$

Which is the order of the ions arranged from strongest to weakest tendency to give up electrons. (STRONGEST to WEAKEST reducing agent)

A. Z^-, X^-, Y^-, W^-
B. W^-, Y^-, X^-, Z^-
C. Y^-, X^-, Z^-, W^-
D. W^-, Y^-, Z^-, X^-

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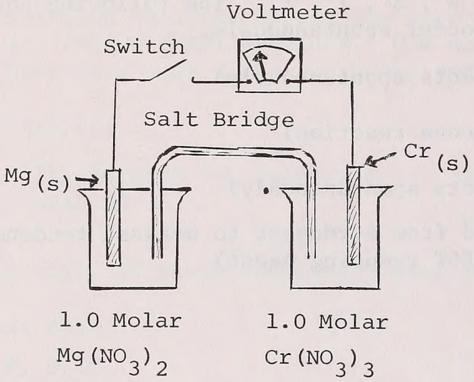
(OVER)

Questions 4-6 relate to this simple electrochemical cell.



The half reactions with E° values are:

$Mg_{(s)} \longrightarrow Mg^{+2}_{(aq)} + 2e^-$ $E° = 2.37$ volts

$Cr_{(s)} \longrightarrow Cr^{+3}_{(aq)} + 3e^-$ $E° = 0.74$ volt

4. When the cell is operating, which ONE of the following statements is FALSE?

   A. The electrode at which oxidation is taking place is the anode of the cell
   B. The voltage of the cell is 1.63 volts
   C. Electrons flow through the voltmeter from chromium to magnesium
   D. Both negative and positive ions move through the solution in the salt bridge

5. If 0.5 Molar solution of Na_2CO_3 is added to the beaker containing chromium $Cr^{+3}_{(aq)}$ ions, which one of the following statements is FALSE?

   A. Chromium carbonate will precipitate
   B. The change which occurs could be qualitatively predicted by using Chatelier's principle
   C. The reading on the voltmeter will decrease
   D. Sodium ions will be reduced after all of the chromium ions have been removed from the solution

6. If new cells were set up in the original arrangement EXCEPT that a copper electrode replaced the chromium electrode in the chromium nitrate solution, which ONE of the following statements describing the new cells in operation would be TRUE?

   A. No electrons would flow in the external circuit
   B. The electrons would flow from the copper electrode to the magnesium
   C. The solution in the right-hand beaker would turn blue
   D. The copper electrode would become plated with solid chromium metal

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Questions 7-10 are related to the following chemical equation which represents the oxidation of methanol to formic acid in a sulfuric acid solution of $KMnO_4$.

$$5CH_3OH_{(\ell)} + 4MnO_{4\,(aq)}^{-} + 12H^{+}_{(aq)} \longrightarrow 5HCOOH_{(\ell)} + 4Mn^{+2}_{(aq)} + 11H_2O$$

7. The methanol molecule (CH_3OH) changes to a formic acid molecule (HCOOH) by having the oxidation number of carbon

A. increased by 4
B. increased by 2
C. decreased by 4
D. decreased by 2

8. According to the equation, how many moles of sulfuric acid (H_2SO_4) would be required to produce one mole of formic acid?

A. 1.0 mole
B. 1.2 moles
C. 2.3 moles
D. 6.0 moles

9. What weight of dry potassium permanganate ($KMnO_4$) would be required to produce one mole of formic acid?

A. 632.0 grams
B. 197.5 grams
C. 158.0 grams
D. 126.4 grams

10. If 1.5 moles of H_2SO_4 were used in the preparation of formic acid, what volume of 6.0 molar sulphuric acid will be required?

A. 0.25 liter
B. 4.0 liters
C. 6.0 liters
D. 9.0 liters

FOR ROUGH WORK ONLY
(No marks given for work in this space)

11. In an electrolysis experiment a quantity of electricity flowed through a series of cells in which potassium, magnesium and aluminum were produced. Which ratio of moles of metals produced would be expected for this experiment?

	Potassium		Magnesium		Aluminum
A.	0.5	:	0.75	:	1.0
B.	1.5	:	3.0	:	4.5
C.	1.0	:	0.5	:	0.25
D.	4.5	:	3.0	:	1.5

12. Deep sea divers often use an air mixture that has had the nitrogen replaced by helium in order to prevent the diver from developing the "bends." This new mixture generally results in a DECREASE in the

A. percentage of oxygen by volume
B. average kinetic energy of all the molecules
C. average velocity of all the molecules
D. density of the sample

13. Which one of the following produces the strongest aqueous acid?

A. H_2Te
B. H_2S
C. H_2O
D. H_2Se

FOR ROUGH WORK ONLY
(No marks given for work in this space)

14. Which of the following factors does NOT influence the magnitude of the ionization energy of a gaseous atom?

A. The pressure in the discharge tube
B. The charge on the nucleus
C. The radius of the atom
D. The number of filled valence orbitals

15. The electron configuration of the As^{-3} ion is

A. $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}$
B. $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^3$
C. $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^6$
D. $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^7, 4p^3$

16. Which of the empirical formulas given is not reasonable for a compound containing arsenic?

A. AsH_3
B. As_2O_3
C. As_3Br
D. Ca_3As_2

FOR ROUGH WORK
(No marks given for work in this space)

Consider the following compounds in answering questions 17-19:

I. $PH_{3(g)}$ II. $BeF_{3(g)}$ III. $SiC_{(s)}$ IV. $CsF_{(s)}$

V. $SiO_{2(s)}$ VI. $OC\ell_{(g)}$ VII. $BaC\ell_{2(s)}$

17. Which of the compounds above exist in the form of molecules?

A. I and V
B. I, II and VI
C. I, II, III and V
D. III, IV, V and VII

18. Which of the compounds have polar molecules?

A. I and VI
B. I, II, V and VI
C. I
D. II, III and V

19. Which of the above compounds are network solids?

A. V
B. III and V
C. III, IV and VII
D. III, IV, V and VII

FOR ROUGH WORK ONLY
(No marks given for work in this space)

20. The compound RbCℓ forms an ionic compound in which the co-ordination number of Rb^+ is found to be 6. The type of packing of the crystal would probably be

A. hexagonal closest packing of interlocking Rb^+ ion and $C\ell^-$ ion pattern
B. body centered cubic closest packing of interlocking Rb^+ ion and $C\ell^-$ ion pattern
C. face centered cubic closest packing of interlocking Rb^+ ion and $C\ell^-$ ion pattern
D. wurtzite lattice

FOR ROUGH WORK ONLY
(No marks given for work in this space)

Questions 21-23 relate to the following compounds:

I. sand (SiO_2)
IV. phosphorous (P_4)
II. anthracene ($C_{14}H_{10}$)
V. sodium metal (Na)
III. rubidium oxide (Rb_2O)

21. Which substance forms a body-centered cubic packed crystal?

A. II
B. III
C. IV
D. V

22. Which substance is not an electrical conductor when SOLID but becomes a conductor when MELTED?

A. II
B. III
C. IV
D. V

23. Which of the above substances are held together in the solid primarily by van der Waals forces?

A. II
B. II and IV
C. III and V
D. IV

FOR ROUGH WORK ONLY
(No marks given for work in this space)

The following compounds are to be used to answer questions 24-28.

I. CH_3COOCH_3

II. CH_3COCH_3

III. $CH_3CH_2NH_2$

IV. $CH_2OHCHOHCH_2OH$

V. $CH_3CONHCH_3$

24. Which compound would show the greatest amount of hydrogen bonding?

A. I
B. II
C. III
D. IV

25. Which compound is formed from an organic acid and alcohol?

A. I
B. II
C. III
D. IV

26. Which compound has a "peptide" or amide linkage?

A. II
B. III
C. IV
D. V

27. Which compound would release 1.5 moles of hydrogen gas when one mole of it is treated with excess of sodium metal?

A. I
B. II
C. III
D. IV

28. Which compound is produced by partial oxidation of iso-propyl alcohol, $CH_3CHOHCH_3$?

A. I
B. II
C. IV
D. V

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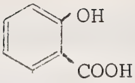
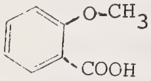
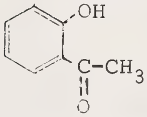
29. When salicylic acid  is made to react with methanol, the main compound formed is

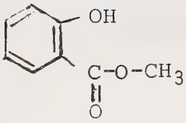
A.



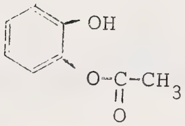
B.



C.



D.



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30. Which of the following equations is NOT a disproportionation reaction?

A. $6H^+_{(aq)} + 5I^-_{(aq)} + IO^-_{3(aq)} \rightarrow 3I_{2(s)} + 3H_2O$

B. $12OH^-_{(aq)} + 4P_{4(s)} + 12H_2O \rightarrow 12H_2PO^-_{4(aq)} + 4PH_{3(g)}$

C. $3C\ell O^-_{(aq)} \rightarrow 2C\ell^-_{(aq)} + C\ell O^-_{3(aq)}$

D. $2OH^-_{(aq)} + 2C\ell O_2 \rightarrow C\ell O^-_{2(aq)} + C\ell O^-_{3(aq)} + H_2O$

31. The bond energies of the halogens show a decrease from $C\ell_{2(g)}$ through $I_{2(g)}$. The main reason for this is that

A. the ionic radii of the halogens are greater than the covalent radii of the halogens
B. as the atomic number increases, the randomness factor also increases which means the energy factor decreases
C. the larger the halogen atoms, the further the bonding electrons are from the two nuclei
D. the larger the atomic number, the greater the van der Waals forces between molecules which thus weakens the intramolecular bond

32. One possible explanation for fluorine being the most active halogen is that it

A. is the least dense of the halogens
B. has seven valence electrons
C. has the smallest atomic radius
D. has the lowest boiling point

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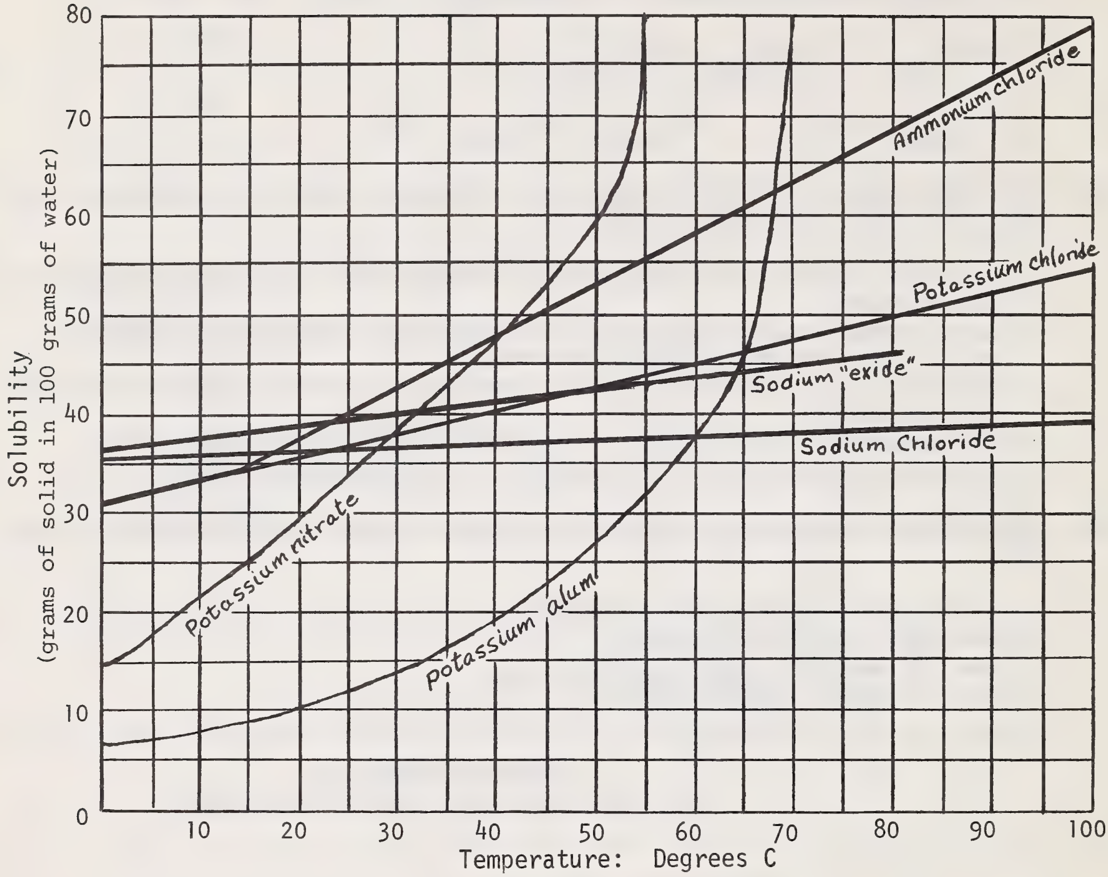
TEMPERATURE - SOLUBILITY GRAPH



Values

PART II

10 33. Using the graph on page 14 and the answer key below, place the LETTER corresponding to the most appropriate answer in the brackets to the right of each statement. Your answers should be based only on the evidence presented by the graph. Each part is worth 1 mark.

KEY:

A. the statement is true
B. the statement is probably true
C. there is not enough evidence given to indicate if the statement is true or false
D. the statement is probably false
E. the statement is false

(a) The solubility of these solids increases as the temperature increases. a. (.....)

(b) The solubility of MOST solids increases as the temperature increases. b. (.....)

(c) Pressure has no effect on the solubility of solids. c. (.....)

(d) The solubility of these solids increases at the same rate as the temperature increases. d. (.....)

(e) At 100 degrees, sodium "exide" has a solubility of about 49 grams. e. (.....)

(f) The solubility of sodium chloride changes the least over the temperature range shown. f. (.....)

(g) At zero degrees, ammonium chloride has the same solubility as potassium chloride. g. (.....)

(h) 100 grams of potassium alum will dissolve in 100 grams of water before 75 degrees is reached. h. (.....)

(i) The most soluble of these solids at 57 degrees is potassium nitrate. i. (.....)

(j) All nitrates have a high solubility at temperatures above 40 degrees. j. (.....)

FOR ROUGH WORK
(No marks given for work in this space)

Values

6 34. At standard conditions, one liter of a gas weighs 1.96 grams. Analysis shows that the gas is 81.8% carbon and 18.2% hydrogen.

(a) Determine the molecular weight.

(b) Determine the correct molecular formula.

FOR ROUGH WORK ONLY
(No marks given for work in this space)

Values

8 35. How many liters of air (20% oxygen) at S.T.P. will be required by your body to convert 50 grams of glucose ($C_6H_{12}O_6$) into CO_2 and water during metabolism (conversion of food to energy). Assume the body is 100% efficient.

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Values

2 36. (a) Sketch the bonding orbitals involved in an atom which has two valence electrons.

2 (b) Sketch the bonding orbitals involved in an atom which has three valence electrons.

2 (c) Sketch the molecular orbital for $OC\ell_2$.

Values

4 37. Balance the following equations.

(a) $KOH_{(s)} + MnO_{2(s)} + KC\ell O_{3(s)} \longrightarrow K_2MnO_{4(s)} + KC\ell_{(s)} + H_2O_{(g)}$

(b) $Br^- + Cr_2O_7^{-2} + H^+ \rightarrow Br_2 + Cr^{+3} + H_2O$

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Values

3 38. It is found that chloroacetic acid, $CH_2C\ell COOH$ is a stronger acid than acetic acid, CH_3COOH. Explain the difference in strength.

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Values

4 39. Three bottles containing liquids and with no labels are found on a shelf. Subsequent tests prove that one substance is secondary butyl alcohol, one substance is n-hexane and the third substance is cyclohexene. Using the information below, match up the name of the substance with its number.

Substance	Boiling Point	Melting Point	Reaction with Sodium	Reaction with Basic $KMnO_4$	Solubility in Water
1	68.7° C	-94.3° C	none	remains purple	0.14 gm/100 mol
2	100° C	-89° C	hydrogen gas is evolved	purple to green	12.5 gms/100 mol
3	83° C	-103.7° C	none	purple to green	insoluble

Substance 1 ....

Substance 2 ....

Substance 3 ....

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